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California Department of Health Services

PERCHLORATE IN CALIFORNIA DRINKING WATER
January 1998 Update

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INTRODUCTION

In early 1997 the Department of Health Services (DHS) Drinking Water Program found the inorganic chemical perchlorate in certain drinking water wells in eastern Sacramento County in northern California. As a result of these initial discoveries and improved laboratory analyses, DHS investigated and found perchlorate in drinking water wells in parts of southern California. Others have subsequently found it in drinking water supplies beyond California's borders. A considerable amount of data has been collected, and a summary of perchlorate findings is presented in this update.

Perchlorate (as ammonium perchlorate) is used in the manufacture of solid rocket propellants, munitions and fireworks. Sources of drinking water have been contaminated by perchlorate in areas in which such manufacturing – or rocket testing – occurred. Outside of California, contamination has occurred associated with the manufacture of ammonium perchlorate, as well.

The primary human health concern related to perchlorate is that it can interfere with the thyroid gland's ability to utilize iodine to produce thyroid hormones, which are required for normal body metabolism, as well as growth and development. Perchlorate in very high doses has been used in medicine in the treatment of Graves' disease, a condition in which excessive amounts of thyroid hormone are produced.

Because perchlorate historically has not been considered a common drinking water contaminant, no federal or state drinking water standards exist. In addition, treatment technologies for the removal of perchlorate from drinking water are currently unavailable.

DHS has adopted an action level for perchlorate in drinking water of 18 micrograms per liter, or parts per billion (ppb). DHS has given advice to utilities about actions that are to be followed when the 18-ppb action level for perchlorate is exceeded.

PERCHLORATE FINDINGS

A number of drinking water wells in public water systems were sampled and analyzed for perchlorate. This testing was done initially by DHS, beginning in February in northern California and in April elsewhere in California. Later testing either by DHS' laboratories or by drinking water systems and commercial laboratories, using the improved analytical method developed by DHS. The results of that

testing through October 31, 1997 are presented below, as reported by the Drinking Water Program's four regions.

Northern California Region

In northern California, perchlorate has been found in eastern Sacramento County. Several sites have been identified as potential sources of perchlorate contamination. These include Aerojet General Corporation's facility, a site formerly owned by McDonnell-Douglas, and a site formerly owned by Purity Oil Company.

As a result of cleanup of contaminated shallow groundwater at Aerojet General Corporation's chemical manufacturing and rocket testing facility near Rancho Cordova, water treated to remove volatile organic chemicals (for example, trichoroethylene, TCE) has been reinjected into groundwater aquifers in the area. This has occurred since the late 1980's. The reinjected water contains up to 8,000 ppb perchlorate, which is also a contributor to the site's shallow groundwater contamination.

In February 1997, perchlorate in drinking water wells in Rancho Cordova was present in concentrations as high as 280 ppb, using a laboratory method sensitive to 35 ppb. In April 1997, using an improved method developed by DHS' Sanitation and Radiation Laboratory (SRL) sensitive to 4 ppb, perchlorate was also found in several other drinking water wells in the area.

Perchlorate in public drinking water wells -- Northern California Region	
Wells tested for perchlorate	53
Wells with detected perchlorate	19
Wells with perchlorate > 18 ppb	8
Wells closed due to perchlorate	5

North Coast Region

DHS has tested drinking water wells in Solano, San Benito, Santa Clara, and Monterey counties, near military bases, rocket motor manufacturing facilities, or other aerospace facilities. Only one drinking water well showed detected levels of perchlorate (14.2 ppb), and this was in one of two samples from a well at United Technologies Corporation in Santa Clara County. DHS has been advised by US EPA Region 9 that groundwater monitoring wells associated with the United Technologies have shown perchlorate at concentrations of up to 180,000 ppb.

DHS has also been advised by the Regional Water Quality Control Board that 9 monitoring wells associated with the Whittaker Ordnance Facility near Hollister in San Benito County and sampled in July 1997 showed perchlorate at concentrations of from 8.4 to 88 ppb. DHS was further advised that an agricultural well in the vicinity contained perchlorate at 34 ppb, and that a private well was found to contain 810 ppb. The residence using the private well was to be provided bottled water by a consultant

to Whittaker. (Note that because this is a private well, it is not included in the summary data for public water system wells.)

Perchlorate in public drinking water wells -- North Coast Region	
Wells tested for perchlorate	26
Wells with detected perchlorate	1
Wells with perchlorate > 18 ppb	0
Wells closed due to perchlorate	0

Central California Region

Testing in San Bernardino and Riverside County should that some drinking water wells in Loma Linda and Redlands were found to contain perchlorate in concentrations of 5 to 216 ppb. Some drinking water wells in the city of Riverside contained low levels of perchlorate (4 to 21 ppb). The perchlorate contamination is in a TCE plume associated with past operations of the Lockheed Propulsion Company. Nine wells have been removed from service.

Perchlorate was also detected in low concentrations (4 to 7 ppb) in certain wells in Chino, Colton and Rancho Cucamonga. It was found in higher concentrations – up to 30 ppb – in certain wells in Rialto, and at 270 ppb in an inactive well near a defunct fireworks site near Rialto.

Sampling of 14 drinking water wells also occurred at Edwards Air Force Base in Kern County. No perchlorate was detected.

Perchlorate in public drinking water wells -- Central California Region	
Wells tested for perchlorate	161
Wells with detected perchlorate	38
Wells with perchlorate > 18 ppb	12
Wells closed due to perchlorate	9

South Coastal Region

Testing of wells in Los Angeles County showed detectable levels of perchlorate in certain wells of drinking water systems that serve parts of Altadena, Arcadia, Azusa, Baldwin Park, Covina, Industry, Irwindale, La Canada Flintridge, La Puente, Monterey Park, Newhall, Pasadena, San Dimas, San Marino,

Santa Clarita, Valenica, and West Covina. Wells have been taken out of service because of perchlorate contamination in the communitites of Altadena, Baldwin Park, Covina, El Monte, and Santa Clarita.

Several sites have been identified as potential sources of perchlorate contamination, including an Aerojet facility (Azusa), the Azusa landfill, the Whittaker-Bermite site (Santa Clarita), and the Jet Propulsion Laboratory (Pasadena).

Perchlorate in public drinking water wells -- South Coast Region	
Wells tested for perchlorate	288
Wells with detected perchlorate	52
Wells with perchlorate > 18 ppb	13
Wells closed due to perchlorate	8

Perchlorate was also found at very low levels (from 5 to 9 ppb) in some samples of Colorado River water. This resulted in investigations outside of California, as discussed below.

Perchlorate Outside of California

In July, monitoring of surface water sources in southern California showed perchlorate in Colorado River water, which provides drinking water to many southern Californians. As a result of these findings, investigations moved upstream, and in August, perchlorate was found in the Colorado River (Lake Mead), at concentrations in some areas as high as 165 ppb. It was also found at up to 1,700 ppb in surface waters – the Las Vegas Wash –that feed into the Lake Mead, and drinking water wells in Las Vegas (up to 13 ppb).

The manufacture of ammonium perchlorate has occurred in the Las Vegas area for several decades. Subsequently, monitoring wells at a current site and a former site of ammonium perchlorate manufacturing were reported to have groundwater concentrations of perchlorate of 3,700,000 and 630,000 ppb, respectively.

In September, perchlorate at concentrations of up to 200 ppb was reported in groundwater associated with a rocket motor manufacturing facility near Magna,Utah.

DHS' ADVICE TO DRINKING WATER UTILITIES

If perchlorate is found in a drinking water supply at concentrations exceeding the 18-ppb action level, DHS will advise the utility to remove the contaminated source from service. Under Section 116455 of the California Health and Safety Code, the water utility is required to notify its City Council whenever a well is removed from service due to chemical contamination. If the source is required to meet system demands and cannot be removed from service, and if drinking water that is provided by the utility exceeds the action level, DHS will advise the utility to arrange for public notification to its customers.

Whenever public notification occurs, information about perchlorate in drinking water is to be provided to the consuming population in the affected area that would not directly receive the public notification, including renters, workers and students.

On August 1, 1997, DHS informed drinking water utilities about its intention to develop a regulation that includes perchlorate as an unregulated chemical for which monitoring is required. DHS recommended that utilities near facilities that use or may have used perchlorate consider voluntary monitoring for perchlorate prior to adoption of that regulation.

In that notice, DHS also informed utilities about the availability of commercial laboratories that have been approved to perform perchlorate analysis using the method developed by DHS. Interested parties should contact SRL at (510) 540-2201 for information on approved laboratories.

DHS' ACTION LEVEL FOR PERCHLORATE

Following the initial northern California findings in February 1997, the DHS Drinking Water Program informed drinking water utilities that the US Environmental Protection Agency (US EPA) had evaluated the health effects of perchlorate as part of its Superfund activities associated with hazardous waste sites. DHS, in cooperation with the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment, reviewed the US EPA reports on the risks to human health from exposure to perchlorate. US EPA reported a range of exposures that would be considered to provide adequate health protection that corresponds to a 4-ppb to 18-ppb range of concentrations.

As a result of that review, DHS established its action level of 18 ppb. Perchlorate concentrations lower than 18 ppb are not considered to pose a health concern for the public, including children and pregnant women.

Basis of DHS' Action Level

The 1992 US EPA evaluation used studies on humans as the most appropriate information for evaluating the health risks of perchlorate. Data were derived from medical patients given perchlorate to treat hyperactive thyroid glands (Graves' disease). The measure of effect was the release of iodine from the thyroid and inhibition of iodine uptake by the thyroid, which were the most sensitive indicators of effects. For these effects, the US EPA identified a no observable adverse effects level (NOAEL) of 0.14 mg/kg/day.

To account for unknowns in the risk assessment process, US EPA applies uncertainty factors (UFs). A UF of 1000 was applied to the NOAEL for perchlorate in its 1992 report. The 1000-fold UF is a product of 10 x 10 x 10, where individual contributors to the UF are:

- 10 for use of a study of short duration, instead of a long-term "chronic" exposure study
- 10 for the protection of sensitive individuals, e.g., individuals with low iodine diets and individuals with genetically impaired iodide accumulation systems in the thyroid
- 10 to account for deficiencies in the data available on the effects of perchlorate

The resulting reference dose (RfD) is 0.0001 mg/kg/day (rounded from 0.00014 mg/kg/day). Using

standard risk assessment parameters (such as a 70-kg body weight, and 2 liters of drinking water per day) gives a result of 4 ppb (rounded from 3.5 ppb).

In 1995 the US EPA reviewed its 1992 report and material submitted by the Perchlorate Study Group. US EPA commented that in its deliberations there was some discussion that a full 10 for data deficiencies may not be required. As a result, US EPA maintained the 1000-fold UF, but also included a 300-fold UF, in which the individual contributors to the UF were identified as:

- 10 for use of a study of short duration, instead of a long-term "chronic" study
- 10 for the protection of sensitive individuals, e.g., individuals with low iodine diets and individuals with genetically impaired iodide accumulation systems in the thyroid
- 3 to account for deficiencies in the data available on the effects of perchlorate

The resulting reference using a UF of 300 dose is 0.0005 mg/kg/day (rounded from 0.00047 mg/kg/day). Using standard risk assessment parameters gives a result of 18 ppb (rounded from 17.5 ppb).

Hence, the range of 4 to 18 ppb represents the span of UFs, from 1000 to 300, based on the same human data.

In its 1995 report, US EPA acknowledged that "there are many questions about the chronic effects of perchlorate left unanswered by the existing data," finding a series of studies that identified fatal bone marrow effects at doses ranging from 6 to 14 mg/kg/day to be "particularly troubling." US EPA concluded, "until adequate chronic data becomes available that addresses the effects of perchlorate on the hematopoietic system [i.e., bone marrow], we feel that the appropriate provisional RfD is in the range of 1 to 5E-4 [i.e., 0.0001 to 0.0005] mg/kg/day."

As a result of reviewing the 1992 and 1995 evaluations of perchlorate by US EPA, DHS' Drinking Water Program considers the 18-ppb concentration of perchlorate in drinking water to be protective of public health.

Notes on US EPA's Provisional Reference Dose for Perchlorate

The study used to determine the RfD was: Stanbury, J.B. and J.B.Wyngaarden, 1952. Effect of perchlorate on the human thyroid gland. *Metabolism* 1: 533-539.

NOAEL= 0.14 mg/kg/day, based on the studies of Graves' disease patients, using the release of iodine from the thyroid and inhibition of iodine uptake by the thyroid as the critical effect.

Reference Dose: 0.0001 mg/kg/day

UF: 1000 (10 for use of less than chronic study, 10 for the protection of sensitive individuals, e.g., individuals with low iodine diets and individuals with genetically impaired iodide accumulation systems in the thyroid, and 10 to account for database deficiencies)

Corresponding drinking water concentration: 4 ppb

Margin of safety relative to thyroid effects (see below): 14,000

Reference Dose: 0.0005 mg/kg/day

UF: 300 (10 for use of less than chronic study, 10 for the protection of sensitive individuals, e.g., individuals with low iodine diets and individuals with genetically impaired iodide accumulation systems in the thyroid, and 3 to account for database deficiencies)

Corresponding drinking water concentration: 18 ppb

Margin of safety relative to thyroid effects: 2,800

Doses of perchlorate above 1.4 mg/kg/day were reported to have adverse effects on the thyroid. In drinking water, this corresponds to (1,400 micrograms/kg/day x 70 kg body weight / 2 L/day =) 49,000 ppb.

Doses of perchlorate of 6-14 mg/kg/day were reported to result in fatal bone marrow effects in Graves' disease patients treated for 2 months or longer. In drinking water, this corresponds to a concentration of (6,000-14,000 micrograms/kg/day x 70 kg / 2 L/day =) 210,000-490,000 ppb.

REFERENCES

US EPA, 1992, Provisional Non-cancer and Cancer Toxicity Values for Potassium Perchlorate (CASRN 7778-74-7) (Aerojet General Corp./CA), Memorandum from Joan S. Dollarhide, Superfund Health Risk Technical Support Center, Environmental Criteria and Assessment Office, Office of Research and Development, to Dan Stralka, US EPA Region IX.

US EPA, 1995, Correspondence from Joan S. Dollarhide, National Center for Environmental Assessment, Office of Research and Development, to Mike Girrard, Chairman, Perchlorate Study Group.

LABORATORY ANALYSES FOR PERCHLORATE

Laboratory Approval Process. If a water utility wishes to have its own laboratory or its contract laboratory perform analyses for perchlorate, the procedure is:

1. Contact the DHS Sanitation and Radiation Laboratory (SRL) for a copy of the method by calling Howard Okamoto at (510) 540-2205 or Bill Steeber at (213) 580-5795. (The laboratory must hold Environmental Laboratory Accreditation Program (ELAP) certification for EPA Method 300.0 -IC. If the lab is not already certified for 300.0, contact ELAP.)

2. The laboratory is expected to develop a Standard Operating Procedure (SOP), determine its Method Detection Limit (MDL), and prepare a data package demonstrating its ability to perform this analysis.

3. When ready, the laboratory is to inform SRL at (510) 540-2201, and we will send an ELAP field auditor to the lab. The auditor will bring along one or more performance evaluation (PE) samples which the laboratory is expected to process while the auditor is present. The laboratory reports the PE data on its letterhead to the auditor.

4. The auditor reports back to the SRL, and submits copies of the SOP, data package, and PE

results, along with his/her recommendation.

5. If the laboratory successfully passed the site visit and performed within the acceptance limits of the PE sample (+/- 10%), SLR will issue a "Letter of Approval" to the laboratory.

APPROVED LABORATORIES

The following laboratories have been approved for perchlorate analysis by SRL:

Laboratory	Address	Telephone
Agriculture & Priority Pollutants Laboratories (APPL) Inc.	4205 West Swift Fresno, CA 93722	(209) 275-2175
E. S. Babcock & Sons, Inc.	6100 Quail Valley Court Riverside, CA 92507	(909) 653-3351
California Laboratory Services (CLS)	3249 Fitzgerald Road Rancho Cordova, CA 95670	(916) 638-7301
Clinical Laboratory of San Bernardino, Inc.	P.O. Box 329 San Bernardino, CA 92402	(909) 825-7693
Columbia Analytical Services, Inc.	2059 Junction Avenue San Jose, CA 95131	(408) 437-2400
Del Mar Analytical	2852 Alton Avenue Irvine, CA 92696	(714) 261-1022
Los Angeles Agricultural Commission, Environmental Toxicology Laboratory	11012 Garfield Ave., Bldg. B South Gate, CA 90280	(562) 940-6778
Metropolitan Water District of Southern California	P.O. Box 54153 Los Angeles, CA 90054	(909) 392-5089
Montgomery Watson Laboratories	555 East Walnut Street Pasadena, CA 91101	(818) 568-6400
Orange County Water District	P. O. Box 8300 Fountain Valley, CA 92728	(714) 378-3200
Weck Laboratories, Inc.	14859 East Clark Avenue Industry, CA 91745	(818) 336-2139

Additional information on the laboratory approval process for perchlorate can be obtained from Dr. Kusum Perera of SRL, at (510) 540-2201.

FOR MORE INFORMATION

For more information on perchlorate in drinking water, please contact Dr. Steven Book of DHS' Drinking Water Program at (916) 323-6111.